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RISK-RATING AND EVALUATION SURVEY FOR SARATOGA SPITTLEBUG IN RED PINE PLANTATIONS

by
Louis F. Wilson[1] and Robert L. Heyd[2]

INTRODUCTION

The Saratoga spittlebug, *Aphrophora saratogensis* (Fitch), is a native insect destructive to several Eastern North American pines, and it is especially injurious to red pine, *Pinus resinosa* Ait. It ranges from Maine to Minnesota and the southern provinces of Canada. The adult insect prefers and often destroys young pines (2'-15' tall) (0.6-4.6 m) in plantations where its nymphal alternate hosts are abundant.

The survey objective is to dermine spittlebug injury to red pine: 1) by risk rating hazard from kinds and abundance of nymphal alternate host plants; and 2) by estimating nymphal populations relative to red pine size and density. The schematic survey model (Figure 1) starts either from an established young pine stand or from unplanted land proposed for red pine planting. The land or stand must first be risk-rated, and then further evaluated if potential damage is moderate or high.

METHODS

Risk-rating can be done anytime between the end of May and September, but nymphal evaluation must be done when the nymphs are present (usually from mid-June to early July). Any forestry aid can make the survey with some instruction and training. Only simple arithmetic is used in the calculations. The following equipment is needed:

1. Risk and Evaluation Form with instructions, plus pencil and clipboard.
2. Measuring tape or a 93' long rope (for measuring plot boundaries).
3. Four flags or posts and a 400' long rope (optional) (for plot corners and boundaries).
4. Measuring pole (for tree heights).
5. Square wooden sampling frame 25" × 25" (for nymphal counts).
6. Pocket calculator (for simple arithmetic).

This survey requires one or more 1 5-acre sample plots to assess the risk and potential damage. The surveyor should take at least one plot sample for each five acres of land -- especially if the ground vegetation is not uniform. Less than one sample plot per five acres should be taken *only* if the area is reasonably large (20 acres or more) or the ground cover is relatively uniform in composition and density.

[1]Principal Insect Ecologist, North Central Forest Experiment Station, U.S. Forest Service, USDA, East Lansing, MI 48823
[2]Forest Entomologist, East Lansing, MI 48823.

RISK-RATING

Saratoga spittlebugs cause economic damage *only* when suitable alternate hosts are abundant. The kinds and density of alternate hosts are considered when selecting planting sites or when evaluating the risk to young red pine stands. There are numerous alternate hosts, but sweet-fern, *Comptonia peregrina* Coult. (Figure 2), is the most important cause of population buildup. Thus, a prospective planting site or plantation can be risk-rated by comparing the percentage of sweet-fern to the percentage of other ground cover.

The risk-rating procedure should be conducted between May and September so that alternate hosts can be easily identified. The only assumptions about the area are: 1) the pine stocking will be or is 200 or more trees per acre, 2) the site is reasonably good for red pine growth (site index 50 or higher), and 3) the spittlebug is present on the site or in the general vicinity. Well-stocked stands of red pine more than 15 feet tall (5 m) and not yet showing visible spittlebug injury symptoms are safe and need not be risk-rated. Trees over 20 feet tall (6 m) are usually safe at any stocking density.

Risk-Rating Procedures: The following procedure is suggested for risk-rating a young red pine plantation or area where red pine is considered for planting:

1. Set up a 1/5-acre plot (93′ × 93′) using flags and rope to mark corners and boundaries.
2. Using the Risk and Evaluation Form, estimate and record the percentage of the ground-cover canopy occupied by sweet-fern in the plot.
3. Then, estimate and record the percentage of the ground-cover canopy occupied by other nymphal hosts (all other broadleaf herbs, ferns, small trees, etc.).
4. Lastly, estimate and record the percentage of ground-cover canopy occupied by all *non* hosts (grasses, lichens, mosses) and bare soil.
5. The three estimates should total 100 percent. If not, re-evaluate and adjust accordingly.
6. Plot the percentage of sweet-fern against the percentage of other hosts on the triangular graph on the form. The point where the coordinates intercept on the graph indicates the risk class for the area rated.

   For example, if you plot 10 percent sweet-fern against 20 percent other hosts, the risk given by the graph is low. If, however, you plot 30 percent sweet-fern against 30 percent other hosts, the risk is high.

Low risk indicates the pine will have a small amount of growth loss. Moderate risk indicates the pines will have some growth loss, an occasional dead or dying shoot (flagging) and some crooked stems. High risk indicates most of the pines will be heavily stunted with crooked stems, and many will be either flagged, top-killed, or dead.

EVALUATION SURVEY

After an unplanted area or plantation is risk-rated, the land manager should decide whether further examination is needed. If the risk is low, the potential damage is also low and further information is unnecessary. If risk is moderate or high, however, further evaluations, decisions, and actions are warranted. Figure 1 shows the scheme for continuing the process.

Unplanted Land: On unplanted land that is risk-rated moderate or high, the land manager has the option to plant, to modify the site before planting, or not to plant. Site modification consists of reducing alternate hosts, especially sweet-fern. Herbicides are sometimes effective (Linnane & Osgood, 1976); plowing up sweet-fern should be avoided as a treatment because it stimulates rather than reduces sweet-fern growth.

Red Pine Planation: In red pine plantations that are risk-rated moderate or high, the potential injury level should be determined. This can be done by estimating the number of spittlebug nymphs relative to the number and size of trees (i.e. tree units) in the stand. The nymphs must be tallied when most are in the third-to-fifth instars (mid-June to early July), because the young nhmphs are difficult to find and the older ones more accurately reflect the adult population. (*NOTE*—trees less than three years old after planting are usually too small for spittlebug attack and need not be checked.)

The following procedure is suggested for the evaluation survey.

1. Establish a 1/5-acre sample plot. If square, this is approximately 93′ × 93′. Place flags or posts at the four corners for demarcation. Ropes may be used to delimit the boundary.
2. Count the number of trees in the sample plot.
3. Determine the average number of whorls per tree. If the trees are the same age, you can determine this easily from two to five trees.
4. Measure tree heights (to nearest ½ foot) from at least 20 trees scattered throughout the plot, and determine their average height.
5. Then, calculate and record the TREE-UNITS for the plot by multiplying: Number of trees × average number of whorls × average tree height.
6. Count the number of nymphs in 50 samples of ground cover using a square 1/10-milacre frame (25″ × 25″). Start at one corner of the plot and proceed systematically up the rows of trees. To get 50 samples evenly spaced in the plot take each sample about 12–13 feet apart. Thus, in a plantation with trees spaced 6′ × 6′ apart, sampling should be about every other tree in every other row. Stagger the sampling locations as displayed in Figure 3 so some are taken in the center of the isle between rows and others are taken next to trees.
7. Drop the frame at each sample location. Be sure not to pre-select or omit specific plants as you sample. Carefully examine all host plants for the nymphs, which will be in spittlemasses at the bases of the hosts (Figure 4). Count and record the nymphs for each sample.
8. After 50 samples, total the count and multiply by 40 to estimate the NUMBER OF NYMPHS for the 1/5-acre plot
9. Calculate and record the NYMPHS PER TREE-UNIT by taking the NUMBER OF NYMPHS PER PLOT and dividing the NUMBER OF TREE UNITS PER PLOT.

NYMPHS PER TREE-UNIT reliably estimates the adult insect population (adult insect-days) per branch) which further determines the potential percentage reduction in tree growth. Table 1 gives nymphs per tree-unit at several levels with corresponding percentage growth reductions. Besides growth reduction, moderate and high spittlebug populations can cause serious degrade, top kill, and whole-tree mortality (see Figure 1 for damage level).

If the potential damage level in high risk areas is low, other areas of lesser risk are probably low as well. If damage levels are borderline and no control is made, a follow-up survey the following year should be made, because spittlebug populations may increase and their feeding damage is cumulative in consecutive years.

Impact Considerations: Control or suppression decisions should not be made lightly as the total ecosystem and socio-economic parameters should be considered. The real impact of an insect to a stand is determined by the management goals set for the stand and *not* by how much damage the insect causes. If the stand is managed strictly for pulp and timber, then at least a cost-benefit analysis should be made and then treated accordingly. If, however, the stand is managed more broadly, one must consider the effects of the injured trees on wildlife, recreation, and other multiple use values. For example, a pocket of dead trees in a stand might be highly beneficial for wildlife, and thus such an area need not be treated at all. Here the insect is providing a positive impact and not a negative one—relative to management goals.

RESULTS

In the Evaluation Survey, if six or fewer nymphs are found per 1/10-milacre the standard error of the estimate should be within 40 percent of the mean. As population densities increase, so does the standard error. With densities of 12–14 nymphs per 1/10-milacre the standard error is commonly 100 percent of the mean.

Table 1 is derived from two regressions. First, the regression of average insects per day per branch $Y = -8.14 + 53.90X$ (nymphs per tree-unit) ($r = .97$; $SE = 6.89$; $n = 14$) is used to convert nymphs per treatment to insects per day per branch. This value is then used to calculate proportionate growth reduction $Y = -.558 + .211(\log X)$ (insects per day per branch) ($r = .78$; $SE = .18$; $n = 83$).

SURVEY COSTS

A 1/5-acre plot can usually be set up and risk rated by one person in about 15 minutes. If the nymphal evaluation survey is made in the same plot an additional 1¾ hours is needed. Thus, each plot requires about two person-hours.

CRITIQUE

Each plantation or field has a unique ground cover association. The number and size of sample sites needed to adequately describe this association varies with ground cover uniformity. Thus, the precision of the risk and evaluation survey is greater in more uniform areas and decreases with increasing diversity of ground cover.

Determining the percentage of ground cover for risk-rating is somewhat subjective and the results will vary slightly with the perception of those doing the evaluation.

Any bias introduced in the selection of the 1/10-milacre samples in the nymphal survey will result in either an over or under estimate of nymphs. The surveyor, for example, should not purposely select sweet-fern (or any plant) when sampling.

In very large plantations spittlebug population density may vary in areas of the planta-

tion with similar ground cover associations due to differential migration, soil differences and micro-climatological variation. Thus, a nymphal survey in one area may not represent an area of similar risk in another part of a large plantation. Hence the need for several survey plots in a large plantation when risk is moderate or high.

The ability to accurately predict future tree injury is dependent upon assessment of spittlebug populations *before* serious tree injury is inflicted. The previous year's injury affects growth response in the current year, so an assessment the year after tree injury is observed will underestimate current injury. Diversity in tree heights, amount of crown per tree and tree spacing resulting from previous attack will result in differential injury with small trees and isolated trees receiving heavier damage. Also, after injury is inflicted, crook, sweep, large knots, and mortality may result causing permanent degrade and loss of future products.

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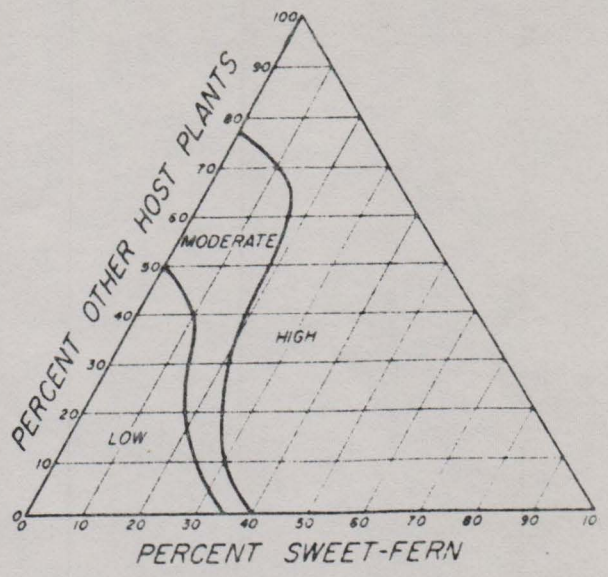
SARATOGA SPITTLEBUG RISK AND NYMPHAL EVALUATION

Field or Plantation No. _____ Date _____

County _____ T. _____ R. _____ S. _____

Sample Plot No. _____ (1/5 acre = 93' x 93')



I. RISK-RATING (1/5 acre plot)

A.	Sweet-fern	_____ %
B.	Other hosts	_____ %
C.	None hosts & bare ground	_____ %
	Total	100 %

Plot A against B on triangle. Risk is (X):

low [ ], moderate [ ], high [ ].

II. TREE-UNITS (1/5 acre plot)

A. Number of trees in plot _____.

B. Average number of branch-whorls per tree (count on 5 trees) _____.

C. Average tree height in feet (from 20 trees) _____.

Sample Number	Tree Height	Sample Number	Tree Height	Sample Number	Tree Height	Sample Number	Tree Height
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Total _____ ÷ 20 = _____

Calculate tree-units by multiplying A x B x C = [ ] TREE-UNITS PER PLOT.

III. NYMPHAL SURVEY (1/5 acre plot)

Take 50 systematic 1/10-milacre samples (1/10-milacre = 25 x 25 in. frame)

Sample Number	No. of Nymphs	Sample Number	No. of Nymphs	Sample Number	No. of Nymphs	Sample Number	No. of Nymphs
1		15		29		43	
2		16		30		44	
3		17		31		45	
4		18		32		46	
5		19		33		47	
6		20		34		48	
7		21		35		49	
8		22		36		50	
9		23		37			
10		24		38		Total	
11		25		39			
12		26		40		NYMPHS PER PLOT =	
13		27		41		Total _____ x 40 =	[ ]
14		28		42			

IV. NYMPHS PER TREE-UNIT = $\frac{\text{NYMPHS PER PLOT}}{\text{TREE-UNITS PER PLOT}}$ = [ ]

Table 1. Growth reductions and damage levels from adult spittlebug feeding corresponding to nymphs per tree-unit values.

Nymphs per tree-unit	Potential Growth Reduction (%)	Damage level*
0.50	6	Low
0.75	18	
1.00	25	
1.50	35	Moderate
2.00	41	
4.00	57	High
6.00	66	
8.00	72	Very High

*See damage level descriptions in Figure 1.

injury and impact from the Saratoga spittlebug.

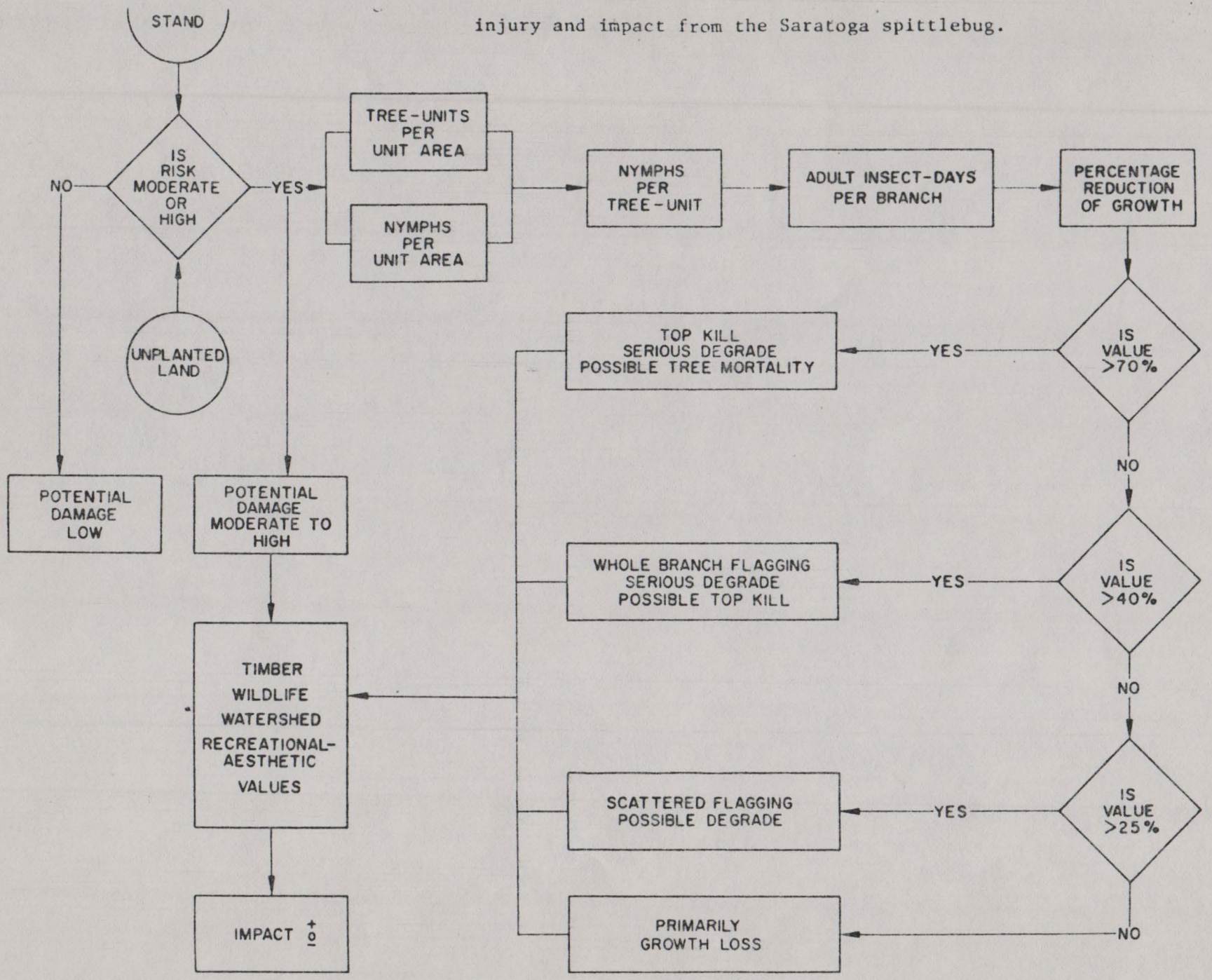


Figure 2. Sweet-fern plant.

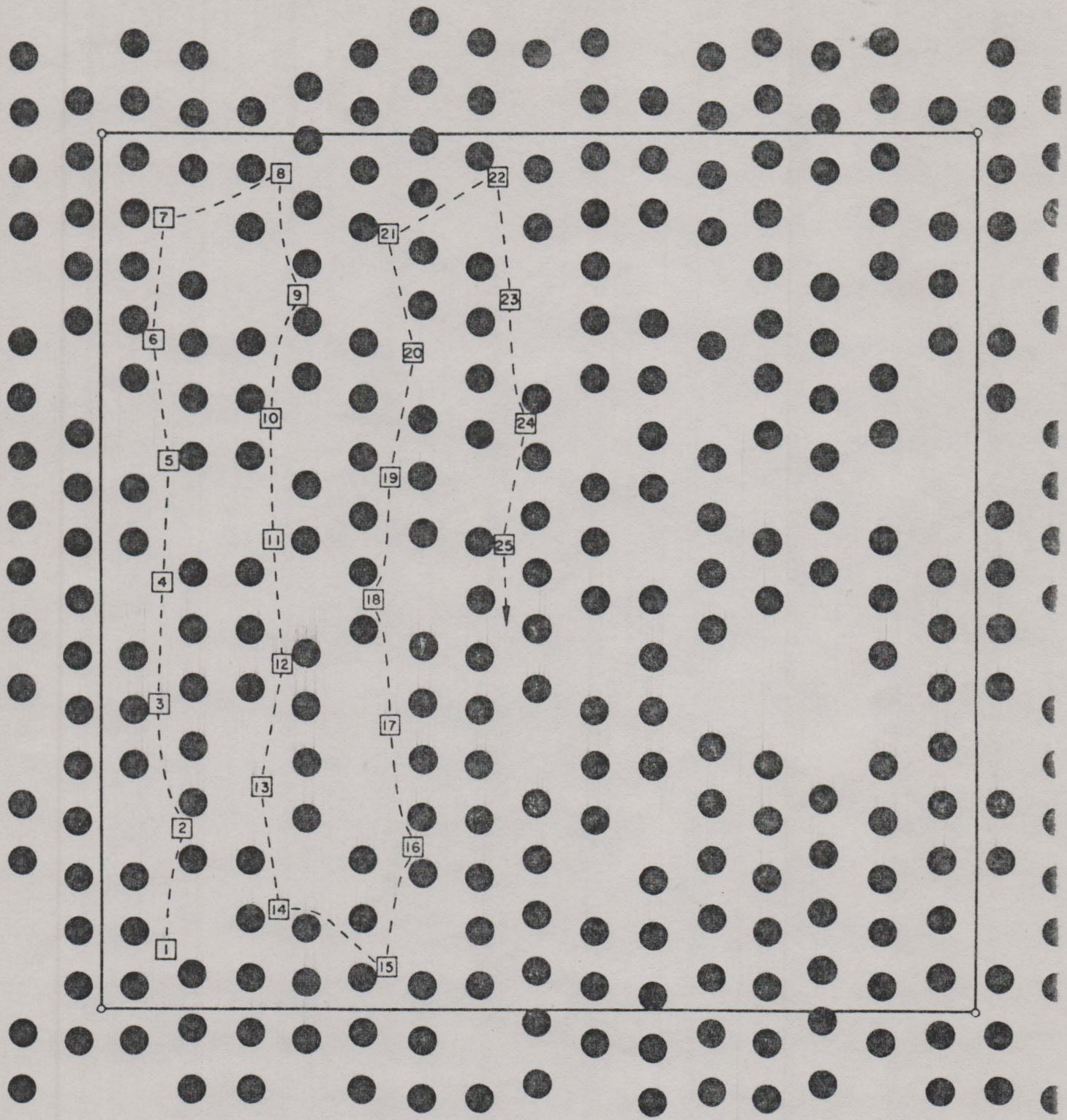


Figure 3. Young red pine plantation showing 1/5-acre plot and suggested nymphal sampling procedure. Black discs are trees. Numbered squares are 1/10 milacre quadrat samples. Starting in one corner, 50 samples taken systematically at roughly every 12 feet down every other row.

Figure 4. Saratoga spittlebug nymph in spittlemass at base of sweet-fern plant.